BRAZED PLATE FIN HEAT EXCHANGER

FIELD OF INVENTION

This invention is directed to heat exchanger fin collars, and more particularly to an improved fin collar for use in a brazed plate fin heat exchanger.

BACKGROUND OF THE INVENTION

Plate fin and tube heat exchangers are used in a wide variety of applications including, but not limited to, air conditioning and refrigeration where it is desired to exchange heat between two fluids, usually a pure liquid or a liquid undergoing a phase change to or from a gas, flowing in the heat exchanger tubes and a gas, usually air, flowing around the heat exchanger plate fins and tube exteriors. In such a heat exchanger, a plurality of thin plate fins are arranged parallel to each other between two tube sheets. Heat exchanger tubes pass through holes in the tube sheets and plate fins. There is a firm fit between the tubes and the plate fins so that the effective surface area, and thus the heat transfer area, of the heat exchanger tubes is increased by the area of the plate fins. Because of this increase in surface area, a plate fin and tube heat exchanger offers improved heat transfer performance over a plain tube type heat exchanger of the same size.

A common method of manufacturing this type of heat exchanger is to first assemble a plurality of plate fins between two tube sheets, then lace a plurality of hair pin tubes through selected holes in the plate fins and similar holes in each of the tube sheets. Next, bells are formed in the end of hairpin tubes, then the legs of the tubes are expanded to insure a tight mechanical fit

between the tubes and plate fins.

In order to improve the thermal and structural bond resulting from mechanical joining of the tubes and plate fins, there is a need for a brazed plate fin heat exchanger with an improved braze joint at the tube-to-fin joint.

SUMMARY OF THE INVENTION

The present invention meets the above-described need by providing a fin collar having a shape that enhances flux application and brazing clad flow into the tube-to-fin joint to provide an improved thermal and structural bond.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is illustrated in the drawings in which like reference characters designate the same or similar parts throughout the figures of which:

Figure 1 is a perspective view of a plate fin heat exchanger of the present invention;

Figure 2 is a perspective view of a tube of the present invention disposed through several plate fins;

Figure 3 is a perspective view of a fin collar of the present invention;

Figure 4 is a perspective view of an alternate embodiment of the fin collar of the present invention;

Figure 5 is a perspective view of another alternate embodiment of the fin collar of the present invention;

Figure 6 is a perspective view of the fin collar of the present invention shown with a representation of the

air flow over the collar; and,

Figure 7 is a top plan view of the fin collar of Figure 6.

DETAILED DESCRIPTION

Fig. 1 depicts a plate fin and tube heat exchanger 10 containing plate fins 12 that embody the present invention. Each plate fin has a plurality of holes 16. A common method of manufacturing heat exchanger 10 is to first assemble a plurality of plate fins 12 between two tube sheets 18, then lace a plurality of hairpin tubes 20 through selected holes 16 in the plate fins 12 and similar holes 16 in each of tube sheets 18. The heat exchanger assembly is completed by fitting up a plurality of return bends 22 to the ends of hairpin tubes 20 so as to form one or more closed fluid flow paths through the tubes of the heat exchanger.

When installed and operating in a device such as an air conditioner, a first fluid, such as a refrigerant, flows through heat exchanger 10 via a fluid flow path or paths defined by interconnected hairpin tubes 20 and return bends 22. A second fluid, such as air, flows over and around plate fins 12 and tubes 20. If there is a temperature differential between the two fluids, then heat transfer from the warmer to the cooler of the two takes place through the tube walls and plate fins.

Turning to Fig. 2, a single tube 20 is shown disposed through a plurality of plate fins 12. Each plate fin 12 is provided with an upstanding fin collar 30 disposed around the openings 16. As shown, the collar 30 may be curved so that a convex surface 31 faces the tube

20. The number of plate fins 12 that can be placed around the tube 20 is determined by the height of the collar 30.

In order to manufacture the heat exchanger of the present invention, the tube 20 to fin 12 joint is brazed in a controlled atmosphere braze furnace. The brazing temperatures will range between 1070°F and 1120°F depending on the clad used.

The tube 20 may be constructed of an aluminum alloy that is clad or unclad. The tube 20 may be roll formed with a welded seam or a lock seam. As an alternative, the tube 20 may be extruded. The tube 20 may have a wall thickness of 0.016″ to 0.05″ depending on the tube diameter and the working pressure. The tube 20 may have a cross-sectional shape that is round, circular, oval, or the like. The tube material is a long life, high strength, corrosion resistant alloy. For extruded tubes, a 3003 aluminum alloy may be used. For roll formed tube an Alcan X-1000 may be used. The clad alloys may be 4045 or 4343 aluminum alloys.

The fins 12 and fin collar 30 may be constructed out of an aluminum alloy 3003 with a 4045 or 4343 alloy clad. If unclad, the fin may be constructed from an 1100 aluminum alloy. The fins may be constructed with a thickness of 0.003″ to 0.016″.

In addition to the aluminum alloys described above, the present invention may be used for brazing a copper fin to copper tubing or brazing an aluminum fin to copper tubing, as will be evident to those of ordinary skill in the art.

In Fig. 3, a first embodiment of the fin collar 30

of the present invention is shown. A plurality of slits 32 are disposed around the circumference of the fin collar 30. The slits 32 may be formed by removing material from the collar and may be disposed equidistantly around the perimeter of the collar 30. The slit may extend from the top 43 of the collar 30 and terminate at a point approximately 0.02″ from the underside of the fin. The slit 32 is defined by a pair of opposed walls 34 and 36. The walls 34 and 36 may be angled such that the width 40 across the slit 32 gradually increases from the bottom 42 of the slit 32 to the top 43 of the collar 30. The slit 32 may range from 0.015″ to 0.15″ in width depending on the collar height and the number of slits. The slits 32 improve the tube-to-fin joint both thermally and structurally.

With regard to structural properties at the joint, the fin collar 30 of the present invention enhances the flux application and the brazing clad flow because the slits 32 allow the cladding to flow through on both sides of the collar 30.

With regard to heat transfer performance, the split fin collar 30 increases heat transfer between the air and tube surfaces. The slits 32 open access to a portion of the surface of the primary tube 20 for the air flow allowing direct heat transfer from air to the tube 20 without the resistance from secondary sources. Ordinarily these portions of the primary tube 20 would be covered by a solid fin collar.

Turning to Fig. 4, an alternate embodiment of the fin collar of the present invention is shown. Fin collar 40 has a rectangular-shaped slit 42. The slit 42 is

defined by a bottom wall 44 and opposed side walls 46 and 48. The bottom wall 44 may extend to a point approximately 0.02″ from the underside of the fin 12. The collars 40 may have a curvature such that they have a convex shape on the side that faces the tubes 20.

In Fig. 5, another alternate embodiment of the fin collar of the present invention is shown. Fin collar 60 is elongated in the longitudinal (tube axis) direction. The collar 60 has a plurality of slits 62 defined therein. The slits 62 also have a rectangular shape and are defined by a bottom wall 64 and a pair of opposed side walls 66, 68. The bottom wall 64 may extend to a point approximately 0.02″ from the underside of the fin 12.

In Figs. 6 and 7, the fin collar 30 of the present invention is shown with arrows 70 representing air flow around the collar 30 during use. The shape of the fin collar 30 provides interruptions around the circumference of the fin collar 30 perpendicular to air flow. The interruptions will provide turbulence, which is indicated by curved lines 80, in the boundary layer of air along the fin collar 30 which will increase the rate of heat transfer between the air and the tube 20. The increased turbulence will also occur around the area near the base of the fin collar 30 in the area of highest fin efficiency, increasing heat transfer rates in that area.

While the invention has been described in connection with certain embodiments, it is not intended to limit the scope of the invention to the particular forms set forth, but, on the contrary, it is intended to cover such alternatives, modifications, and equivalents as may be

included within the spirit and scope of the invention as defined by the appended claims.